Claims

What is claimed is:

1. A method for transitioning from a first mode of fuel injection operation to a second mode of fuel injection operation in an engine having x combustion chambers, comprising:

operating in a first mode of fuel injection operation for the x combustion chambers during a first predetermined engine cycle, the first mode of fuel injection including at least one fuel shot per engine cycle;

operating in the first mode of fuel injection operation for y combustion chambers, y being a number less than x, during a second predetermined engine cycle;

operating in the second mode of fuel injection operation for the remaining x-y combustion chambers during the second predetermined engine cycle, the second mode of fuel injection including at least one fuel shot per engine cycle; and

operating in the second mode of fuel injection operation for the x combustion chambers during a third predetermined engine cycle.

2. The method of claim 1 wherein the engine cycle comprises an intake, compression, power, and exhaust operation for each combustion chamber of the engine.

3. The method of claim 1, further comprising:

operating in the first mode of fuel injection operation for z combustion chambers, z being less than x but greater than y, during a fourth predetermined engine cycle, the fourth predetermined engine cycle occurring after the second predetermined engine cycle and before the third predetermined engine cycle; and

operating in the second mode of fuel injection operation for the remaining x-z combustion chambers during the fourth predetermined engine cycle.

4. The method of claim 1 wherein the first mode of fuel injection comprises delivering a first number of fuel shots to each combustion chamber; and

wherein the second mode of fuel injection comprises delivering a second number of fuel shots to each combustion chamber.

5. A method for transitioning from a first mode of fuel injection having a first number of fuel shots to a second mode of fuel injection operation having a second number of fuel shots in an engine having x combustion chambers, comprising:

delivering a first number of fuel shots to the x combustion chambers during a first predetermined engine cycle, the first number of fuel shots being at least one;

delivering the first number of fuel shots to y combustion chambers, y being a number less than x, during a second predetermined engine cycle;

delivering a second number of fuel shots to the remaining x-y combustion chambers during the second predetermined engine cycle, the second number of fuel shots being at least one; and

delivering the second number of fuel shots to the x combustion chambers during a third predetermined engine cycle.

6. A method for operating a fuel injection system of an engine, comprising:

delivering a first number of fuel shots to a first number of combustion chambers during a first engine cycle, the first number of fuel shots being at least one; and

delivering a second number of fuel shots to a second number of combustion chambers during the first engine cycle, the second number of fuel shots being at least two.

7. The method of claim 1 wherein the engine cycle comprises an intake, compression, power, and exhaust operation for each combustion chamber of the engine.

8. The method of claim 1 wherein the engine comprises a reciprocating engine.

9. The method of claim 1 wherein the engine comprises a rotary engine.

10. The method of claim 1 wherein the combustion chambers comprise cylinders.

11. A method for operating a fuel injection system, comprising:

delivering a first number of fuel shots to a first number of combustion chambers, the first number of fuel shots being at least one; and

delivering a second number of fuel shots to a second number of combustion chambers while the first number of fuel shots is being delivered to the first number of combustion chambers, the second number of fuel shots being at least two.

12. A method for operating a fuel injection system, comprising:

delivering a first number of fuel shots to a first number of combustion chambers during a first predetermined time period, the first number of fuel shots being at least one; and

delivering a second number of fuel shots to a second number of combustion chambers during the first predetermined time period, the second number of fuel shots being at least two.

13. A method for operating a fuel injection system of an engine, comprising:

operating a first number of the fuel injectors in a first mode during a first engine cycle, the first mode having a first set of fuel delivery characteristics, the first set of fuel delivery characteristics including at least one fuel shot per fuel injector per engine cycle; and

operating a second number of the fuel injectors in a second mode during the first engine cycle, the second mode having a second set of fuel delivery characteristics, the second set of delivery characteristics including at least one fuel shot per fuel injector per engine cycle.

14. The method of claim 13 wherein the set of fuel delivery characteristics comprises a number of fuel shots.

15. The method of claim 13 wherein the set of fuel delivery characteristics comprises desired fuel volume of fuel shots.

16. The method of claim 13 wherein the set of fuel delivery characteristics comprises timing of the initiation of fuel delivery.

17. The method of claim 16 wherein the first mode comprises the fuel injector initiating the delivery of fuel at least 4 degrees of crank angle different from the initiation of the delivery of fuel when the fuel injector is in the second mode.

18. A method for operating fuel injectors in an engine having 6 cylinders, comprising:

delivering two shots of fuel to 6 cylinders of the engine during a first engine cycle;

delivering two shots of fuel to 3 cylinders of the engine during a second engine cycle;

delivering one shot of fuel to 3 cylinders of the engine during the second engine cycle;

delivering two shots of fuel to 2 cylinders of the engine during a third engine cycle;

delivering one shot of fuel to 4 cylinders of the engine during the third engine cycle;

delivering two shots of fuel to 1 cylinders of the engine during a fourth engine cycle;

delivering one shot of fuel to 5 cylinders of the engine during the fourth engine cycle; and

delivering one shot of fuel to 6 cylinders of the engine during a fifth engine cycle.

19. The method of claim 18 wherein the first through fifth engine cycles occur chronologically in the order of first, second, third, fourth, and fifth.

20. The method of claim 18 wherein the first through fifth engine cycles occur chronologically in the order of fifth, fourth, third, second, and first.